CAN N-RICH CHARCOAL BE USED AS AN EFFICIENT N FERTILIZER?

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After wild fires, considerable amounts of charred vegetation residues can be incorporated into the soil. They derive from incomplete combustion and contribute to the pyrogenic organic matter (PyOM) or as it is also referred to as "Black Carbon" pool of soils.

However, since depending on the source material, this material can contain a considerable amount of organic nitrogen as an integral part of PyOM, the ecological role of the so called "Black nitrogen" (BN) should not remain unobserved. Most of Mediterranean soils are poor in organic matter (OM) and have also low nutrient bioavailability.

In order to obtain a better understanding of the impact of charcoal on the nitrogen (N) cycling in soil, ^{15}N enriched pyrogenic organic material (PyOM) obtained from "Lolium perenne" charred for 4 minutes at 350ºC was mixed with a typical Mediterranean agricultural soil (*calcareous Rhodoxeralf*) and incubated for 72 days under controlled conditions.

The main objectives were to analyse the availability of N from this material and to obtain more insight into the recalcitrance of PyOM in soils. Addition of artificially produced ^{15}N-PyOM increased the biomass production and N retention. After 72 days of incubation time, 10% of the ^{15}N added to the soil (^{15}Nadd) was incorporated into new grass biomass.

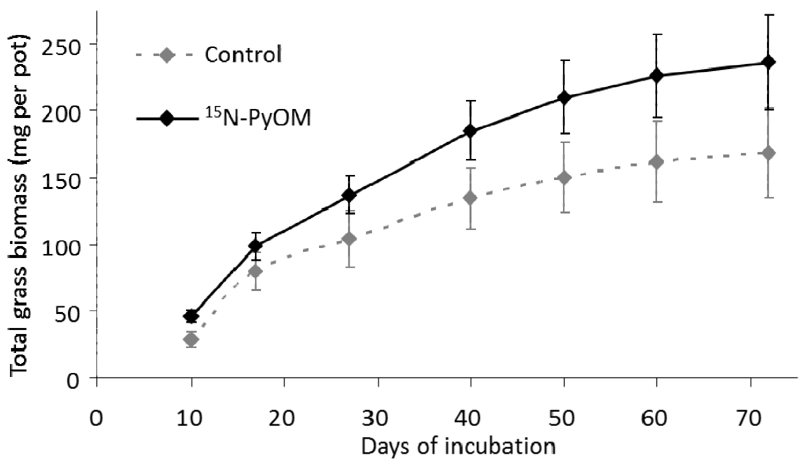

Figure 1. Aboveground biomass production of Lolium perenne grown on with and without addition of ^{15}N-enriched PyOM. Biomass values are given per pot.

Solid-state ^{15}N NMR spectroscopy revealed that at least some of this N derived from the degradation of pyrrole-type structures. Increase of the amide-N intensity in the solid-state ^{15}N NMR spectrum of the incubated soils indicated further that some ^{15}N from the PyOM was also incorporated into new microbial biomass.

Considering that BN components represent a large part of the organic C in grass chars, their fast degradation implies that such material may not as recalcitrant during long-term humification as formerly thought, which is in agreement with recent studies revealing relatively short mean residence times of less than 100 years (Hamer et al., 2004; De la Rosa and Knicker, 2011). Although we are aware that the optimized laboratory conditions and the use of finely pulverized PyOM promoted a much faster degradation than expected in natural soil systems, the relatively fast but controlled availability of N from N-rich PyOM suggests a relatively low recalcitrance of N-rich PyOM. Since during its degradation, N is only slowly transferred into a plant-available form, it may contribute to the observed improvement of soil fertility by avoiding fast N-losses due to leaching and volatilization as a slow N-release fertilizer.

Therefore, with the present study we were able to demonstrate for the first time that in fire affected soils, the N used for the build-up of new plant material can also derive from the mobilization of organic N previously bound in PyOM. Consequently, N-rich PyOM operates as an organic N-fertilizer.

REFERENCES

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